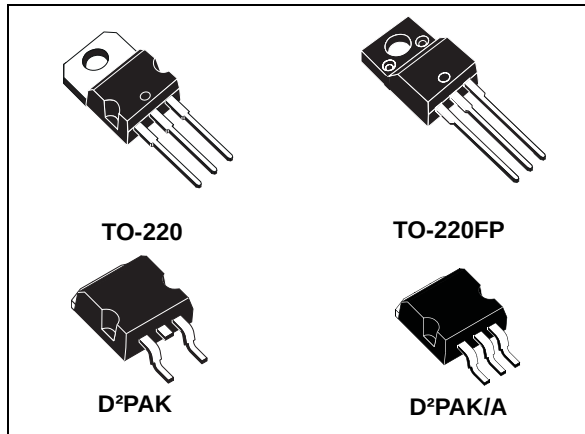


3 A low drop positive voltage regulator: adjustable and fixed

Datasheet - production data



Unlike PNP regulators, where a part of the output current is wasted as quiescent current, the LD1085 quiescent current flows into the load, thus increase efficiency. Only a 10 μ F minimum capacitor is need for stability.

The device is supplied in TO-220, TO-220FP, D²PAK and D²PAK/A packages. On-chip trimming allows the regulator to reach a very tight output voltage tolerance, within $\pm 1\%$ at 25 °C.

Features

- Typical dropout 1.3 V (at 3 A)
- Three terminal adjustable or fixed output voltage 1.8 V, 2.5 V, 3.3 V, 5 V
- Guaranteed output current up to 3 A
- Output tolerance $\pm 1\%$ at 25 °C and $\pm 2\%$ in full temperature range
- Internal power and thermal limit
- Wide operating temperature range -40 °C to 125 °C
- Package available: TO-220, TO-220FP, D²PAK, D²PAK/A
- Pinout compatibility with standard adjustable VREG

Description

The LD1085 is a low drop voltage regulator able to provide up to 3 A of output current. Dropout is guaranteed at a maximum of 1.2 V at the maximum output current, decreasing at lower loads. The LD1085 is pin-to-pin compatible with the older 3-terminal adjustable regulators, but offers better performance in terms of drop and output tolerance.

Contents

1 **Diagram 3**

2 **Pin configuration 4**

3 **Maximum ratings 5**

4 **Application schematic 6**

5 **Electrical characteristics 7**

6 **Typical characteristics 12**

7 **Package mechanical data 16**

8 **Packaging mechanical data 23**

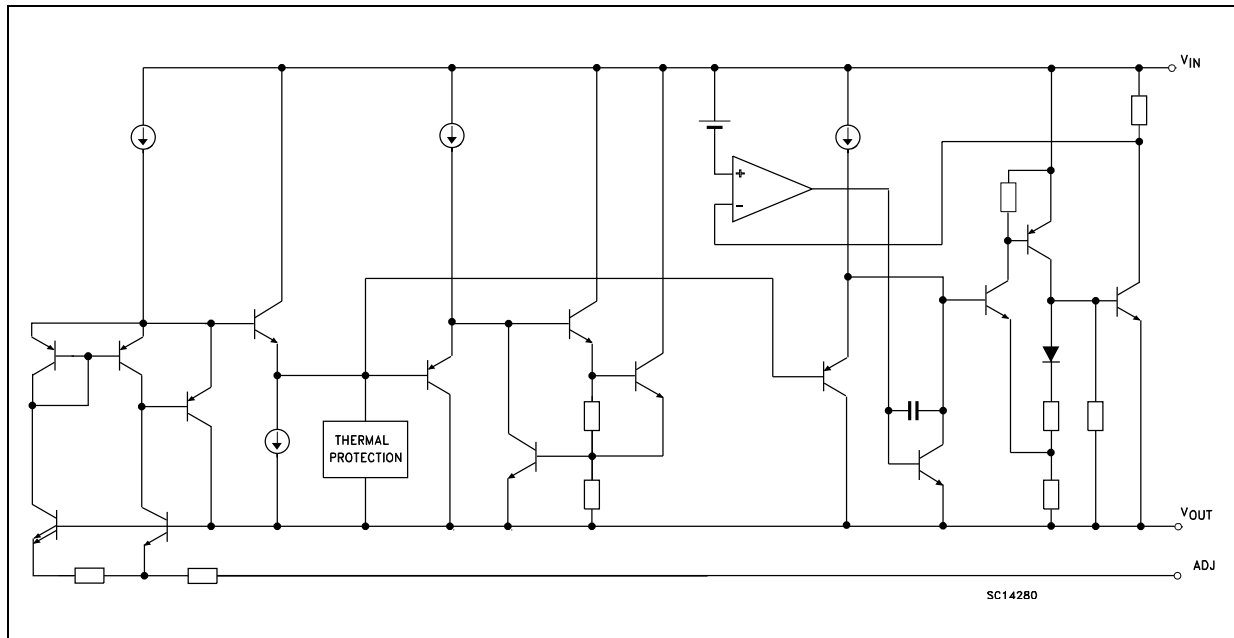
9 **Order codes 26**

10 **Revision history 27**



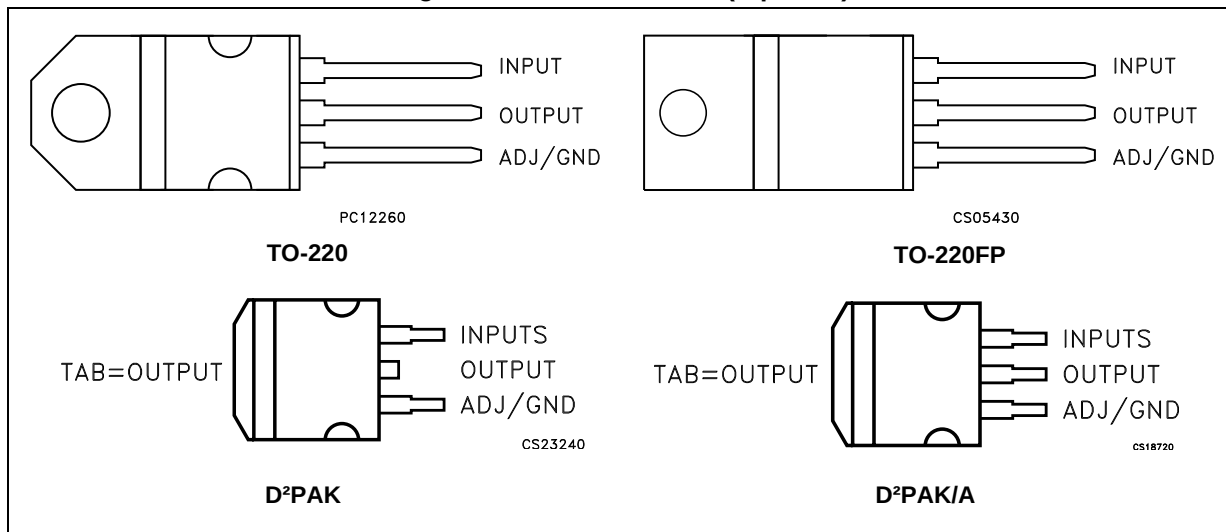
1 Diagram

Figure 1. Schematic diagram



2 Pin configuration

Figure 2. Pin connections (top view)



3 Maximum ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_I	DC input voltage	30	V
I_O	Output current	Internally limited	mA
P_D	Power dissipation	Internally limited	mW
T_{STG}	Storage temperature range	-55 to +150	°C
T_{OP}	Operating junction temperature range	-40 to +125	°C

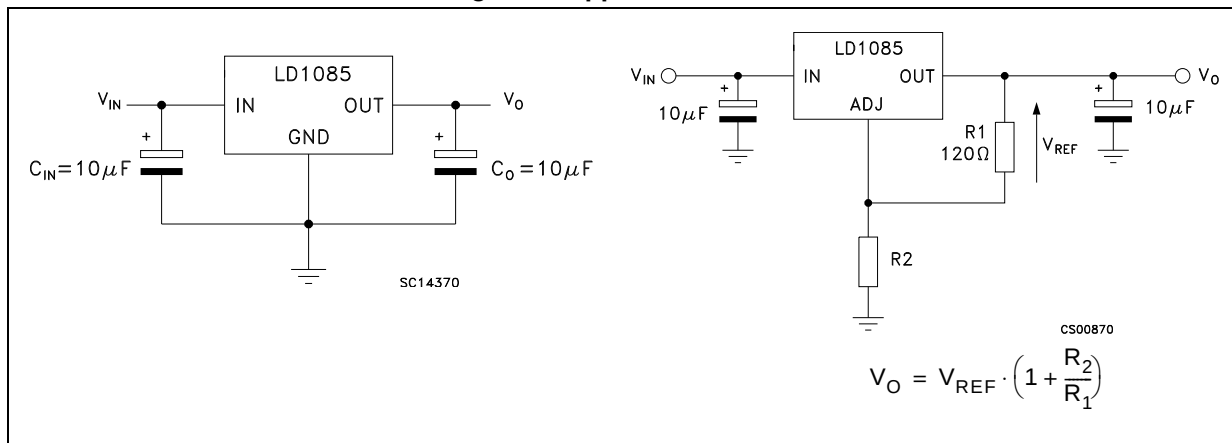
Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied

Table 2. Thermal data

Symbol	Parameter	TO-220	TO-220FP	D ² PAK D ² PAK/A	Unit
R_{thJC}	Thermal resistance junction-case	3	5	3	°C/W
R_{thJA}	Thermal resistance junction-ambient	50	60	62.5	°C/W

4 Application schematic

Figure 3. Application circuit



5 Electrical characteristics

$V_I = 4.8\text{ V}$, $C_I = C_O = 10\text{ }\mu\text{F}$, $T_A = -40\text{ to }125\text{ }^\circ\text{C}$, unless otherwise specified.

Table 3. Electrical characteristics of LD1085#18

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_O	Output voltage ⁽¹⁾	$I_O = 0\text{ mA}$, $T_J = 25^\circ\text{C}$	1.782	1.8	1.818	V
		$I_O = 0\text{ to }3\text{ A}$, $V_I = 3.4\text{ to }30\text{ V}$	1.764	1.8	1.836	V
ΔV_O	Line regulation	$I_O = 0\text{ mA}$, $V_I = 3.4\text{ to }18\text{ V}$, $T_J = 25^\circ\text{C}$		0.2	4	mV
		$I_O = 0\text{ mA}$, $V_I = 3.4\text{ to }15\text{ V}$		0.4	4	mV
ΔV_O	Load regulation	$I_O = 0\text{ to }3\text{ A}$, $T_J = 25^\circ\text{C}$		2	10	mV
		$I_O = 0\text{ to }3\text{ A}$		4	20	mV
V_d	Dropout voltage	$I_O = 3\text{ A}$		1.3	1.5	V
I_q	Quiescent current	$V_I \leq 30\text{ V}$		5	10	mA
I_{sc}	Short-circuit current	$V_I - V_O = 5\text{ V}$	3.2	4.5		A
		$V_I - V_O = 25\text{ V}$	0.2	0.5		A
	Thermal regulation	$T_A = 25^\circ\text{C}$, 30 ms pulse		0.008	0.04	%/W
SVR	Supply voltage rejection	$f = 120\text{ Hz}$, $C_O = 25\text{ }\mu\text{F}$, $I_O = 3\text{ A}$ $V_I = 7.5 \pm 3\text{ V}$	60	72		dB
eN	RMS output noise voltage (% of V_O)	$T_A = 25^\circ\text{C}$, $f = 10\text{ Hz to }10\text{ kHz}$		0.003		%
S	Temperature stability			0.5		%
S	Long term stability	$T_A = 125^\circ\text{C}$, 1000 Hrs		0.5		%

1. See short-circuit current curve for available output current at fixed dropout.

$V_I = 5.5\text{ V}$, $C_I = C_O = 10\text{ }\mu\text{F}$, $T_A = -40\text{ to }125\text{ }^\circ\text{C}$, unless otherwise specified.

Table 4. Electrical characteristics of LD1085#25

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_O	Output voltage ⁽¹⁾	$I_O = 0\text{ mA}$, $T_J = 25^\circ\text{C}$	2.475	2.5	2.525	V
		$I_O = 0\text{ to }3\text{ A}$, $V_I = 4.1\text{ to }30\text{ V}$	2.45	2.5	2.55	V
ΔV_O	Line regulation	$I_O = 0\text{ mA}$, $V_I = 4.1\text{ to }18\text{ V}$, $T_J = 25^\circ\text{C}$		0.2	4	mV
		$I_O = 0\text{ mA}$, $V_I = 4.1\text{ to }18\text{ V}$		0.4	4	mV
ΔV_O	Load regulation	$I_O = 0\text{ to }3\text{ A}$, $T_J = 25^\circ\text{C}$		2	10	mV
		$I_O = 0\text{ to }3\text{ A}$		4	20	mV
V_d	Dropout voltage	$I_O = 3\text{ A}$		1.3	1.5	V
I_q	Quiescent current	$V_I \leq 30\text{ V}$		5	10	mA
I_{sc}	Short-circuit current	$V_I - V_O = 5\text{ V}$	3.2	4.5		A
		$V_I - V_O = 25\text{ V}$	0.2	0.5		A
	Thermal regulation	$T_A = 25^\circ\text{C}$, 30ms pulse		0.008	0.04	%/W
SVR	Supply voltage rejection	$f = 120\text{ Hz}$, $C_O = 25\mu\text{F}$, $I_O = 3\text{ A}$ $V_I = 7.5 \pm 3\text{ V}$	60	72		dB
eN	RMS output noise voltage (% of V_O)	$T_A = 25^\circ\text{C}$, $f = 10\text{ Hz to }10\text{ kHz}$		0.003		%
S	Temperature stability			0.5		%
S	Long term stability	$T_A = 125^\circ\text{C}$, 1000 Hrs		0.5		%

1. See short-circuit current curve for available output current at fixed dropout.

$V_I = 6.3 \text{ V}$, $C_I = C_O = 10 \mu\text{F}$, $T_A = -40 \text{ to } 125 \text{ }^\circ\text{C}$, unless otherwise specified.

Table 5. Electrical characteristics of LD1085#33

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_O	Output voltage ⁽¹⁾	$I_O = 0 \text{ mA}$, $T_J = 25^\circ\text{C}$	3.267	3.3	3.333	V
		$I_O = 0 \text{ to } 3 \text{ A}$, $V_I = 4.9 \text{ to } 30 \text{ V}$	3.234	3.35	3.366	V
ΔV_O	Line regulation	$I_O = 0 \text{ mA}$, $V_I = 4.9 \text{ to } 18 \text{ V}$, $T_J = 25^\circ\text{C}$		0.5	6	mV
		$I_O = 0 \text{ mA}$, $V_I = 4.9 \text{ to } 18 \text{ V}$		1	6	mV
ΔV_O	Load regulation	$I_O = 0 \text{ to } 3 \text{ A}$, $T_J = 25^\circ\text{C}$		3	15	mV
		$I_O = 0 \text{ to } 3 \text{ A}$		7	20	mV
V_d	Dropout voltage	$I_O = 3 \text{ A}$		1.3	1.5	V
I_q	Quiescent current	$V_I \leq 30 \text{ V}$		5	10	mA
I_{sc}	Short-circuit current	$V_I - V_O = 5 \text{ V}$	3.2	4.5		A
		$V_I - V_O = 25 \text{ V}$	0.2	0.5		A
	Thermal regulation	$T_A = 25^\circ\text{C}$, 30 ms pulse		0.008	0.04	%/W
SVR	Supply voltage rejection	$f = 120 \text{ Hz}$, $C_O = 25 \mu\text{F}$, $I_O = 3 \text{ A}$ $V_I = 8.3 \pm 3 \text{ V}$	60	72		dB
eN	RMS output noise voltage (% of V_O)	$T_A = 25^\circ\text{C}$, $f = 10 \text{ Hz to } 10 \text{ kHz}$		0.003		%
S	Temperature stability			0.5		%
S	Long term stability	$T_A = 125^\circ\text{C}$, 1000 Hrs		0.5		%

1. See short-circuit current curve for available output current at fixed dropout.

$V_I = 8\text{ V}$, $C_I = C_O = 10\text{ }\mu\text{F}$, $T_A = -40\text{ to }125\text{ }^\circ\text{C}$, unless otherwise specified.

Table 6. Electrical characteristics of LD1085#50

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_O	Output voltage ⁽¹⁾	$I_O = 0\text{ mA}$, $T_J = 25^\circ\text{C}$	4.95	5	5.05	V
		$I_O = 0\text{ to }3\text{ A}$, $V_I = 6.6\text{ to }30\text{ V}$	4.9	5	5.1	V
ΔV_O	Line regulation	$I_O = 0\text{ mA}$, $V_I = 6.6\text{ to }20\text{ V}$, $T_J = 25^\circ\text{C}$		0.5	10	mV
		$I_O = 0\text{ mA}$, $V_I = 6.6\text{ to }20\text{ V}$		1	10	mV
ΔV_O	Load regulation	$I_O = 0\text{ to }3\text{ A}$, $T_J = 25^\circ\text{C}$		5	10	mV
		$I_O = 0\text{ to }3\text{ A}$		10	35	mV
V_d	Dropout voltage	$I_O = 3\text{ A}$		1.3	1.5	V
I_q	Quiescent current	$V_I \leq 30\text{ V}$		5	10	mA
I_{sc}	Short-circuit current	$V_I - V_O = 5\text{ V}$	3.2	4.5		A
		$V_I - V_O = 25\text{ V}$	0.2	0.5		A
	Thermal regulation	$T_A = 25^\circ\text{C}$, 30 ms pulse		0.008	0.04	%/W
SVR	Supply voltage rejection	$f = 120\text{ Hz}$, $C_O = 25\text{ }\mu\text{F}$, $I_O = 3\text{ A}$ $V_I = 10 \pm 3\text{ V}$	60	72		dB
eN	RMS output noise voltage (% of V_O)	$T_A = 25^\circ\text{C}$, $f = 10\text{ Hz to }10\text{ kHz}$		0.003		%
S	Temperature stability			0.5		%
S	Long term stability	$T_A = 125^\circ\text{C}$, 1000 Hrs		0.5		%

1. See short-circuit current curve for available output current at fixed dropout.

$V_I = 4.25\text{ V}$, $C_I = C_O = 10\text{ }\mu\text{F}$, $T_A = -40\text{ to }125\text{ }^\circ\text{C}$, unless otherwise specified.

Table 7. Electrical characteristics of LD1085#

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_{ref}	Reference voltage ⁽¹⁾	$I_O = 10\text{ mA}$, $T_J = 25^\circ\text{C}$	1.237	1.25	1.263	V
		$I_O = 10\text{ mA}$ to 3 A , $V_I = 2.85\text{ to }30\text{ V}$	1.225	1.25	1.275	V
ΔV_O	Line regulation	$I_O = 10\text{ mA}$, $V_I = 2.85\text{ to }16.5\text{ V}$, $T_J = 25^\circ\text{C}$		0.015	0.2	%
		$I_O = 10\text{ mA}$, $V_I = 2.85\text{ to }16.5\text{ V}$		0.035	0.2	%
ΔV_O	Load regulation	$I_O = 10\text{ mA}$ to 3 A , $T_J = 25^\circ\text{C}$		0.1	0.3	%
		$I_O = 0\text{ to }3\text{ A}$		0.2	0.4	%
V_d	Dropout voltage	$I_O = 3\text{ A}$		1.3	1.5	V
$I_{O(\text{min})}$	Minimum load current	$V_I = 30\text{ V}$		3	10	mA
I_{sc}	Short-circuit current	$V_I - V_O = 5\text{ V}$	5.5	6.5		A
		$V_I - V_O = 25\text{ V}$	0.5	0.7		A
	Thermal regulation	$T_A = 25^\circ\text{C}$, 30ms pulse		0.003	0.015	%/W
SVR	Supply voltage rejection	$f = 120\text{ Hz}$, $C_O = 25\text{ }\mu\text{F}$, $C_{\text{ADJ}} = 25\text{ }\mu\text{F}$, $I_O = 3\text{ A}$, $V_I = 6.25 \pm 3\text{ V}$	60	72		dB
I_{ADJ}	Adjust pin current	$V_I = 4.25\text{ V}$, $I_O = 10\text{ mA}$		55	120	μA
ΔI_{ADJ}	Adjust pin current change ⁽¹⁾	$I_O = 10\text{ mA}$ to 3 A , $V_I = 2.85\text{ to }16.5\text{ V}$		0.2	5	μA
eN	RMS output noise voltage (% of V_O)	$T_A = 25^\circ\text{C}$, $f = 10\text{ Hz to }10\text{ kHz}$		0.003		%
S	Temperature stability			0.5		%
S	Long term stability	$T_A = 125^\circ\text{C}$, 1000 Hrs		0.5		%

1. See short-circuit current curve for available output current at fixed dropout.

6 Typical characteristics

Unless otherwise specified $T_J = 25\text{ }^{\circ}\text{C}$, $C_I = C_O = 10\text{ }\mu\text{F}$.

Figure 4. Output voltage vs. temp. ($I_O = 3\text{ A}$)

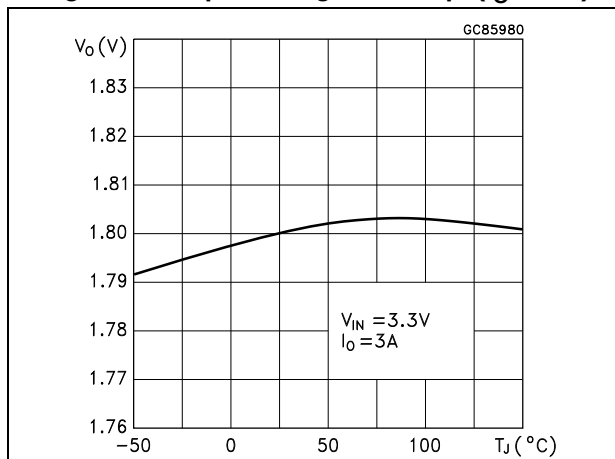


Figure 5. Output voltage vs. temp. ($I_O = 0\text{ mA}$)

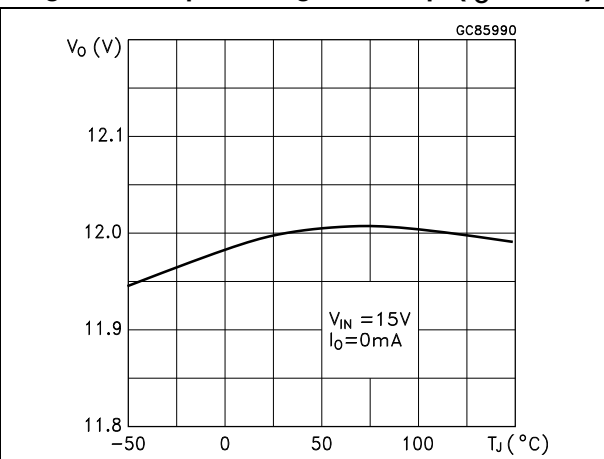


Figure 6. Output voltage vs. temp. ($I_O = 10\text{ mA}$)

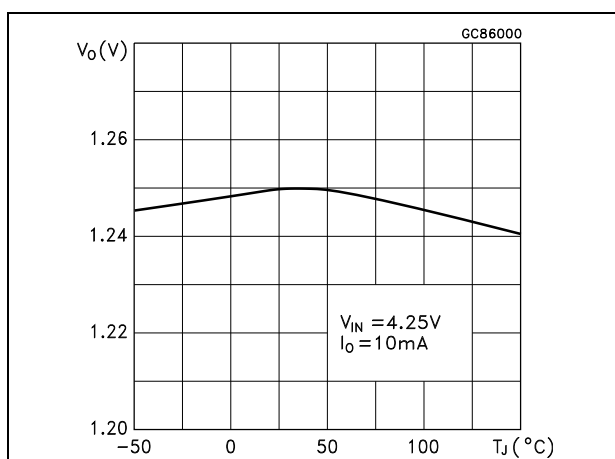


Figure 7. Short-circuit current vs. dropout voltage

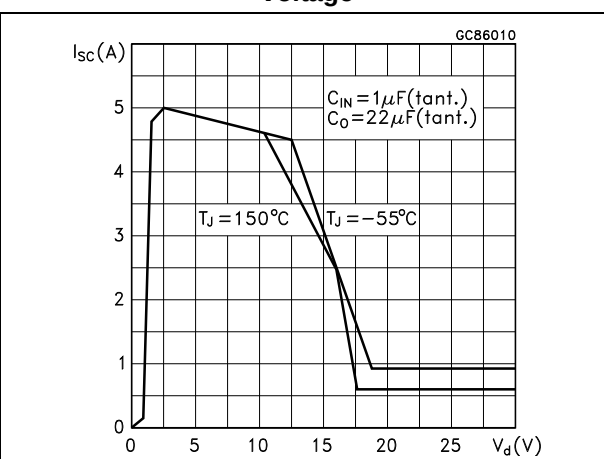


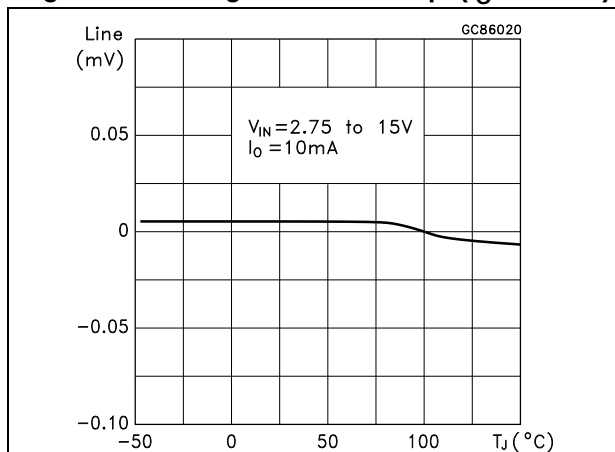
Figure 8. Line regulation vs. temp. ($I_O = 10\text{ mA}$)

Figure 9. Load regulation vs. temperature

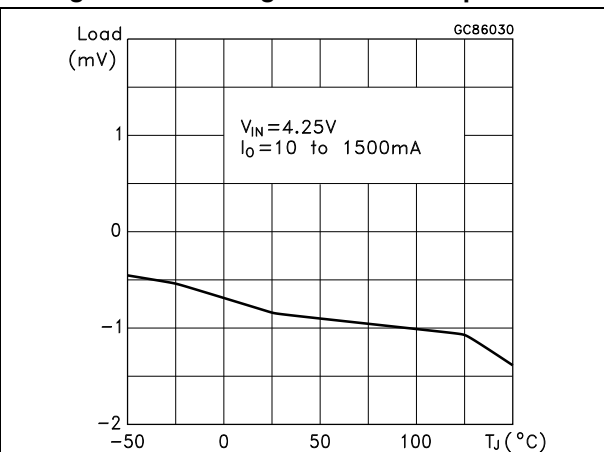


Figure 10. Dropout voltage vs. temperature

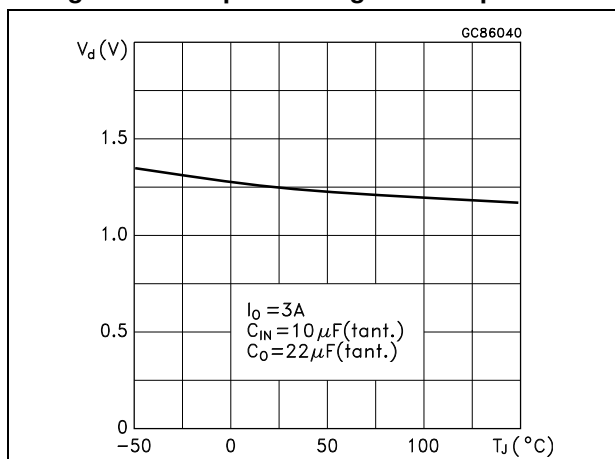


Figure 11. Dropout voltage vs. output current

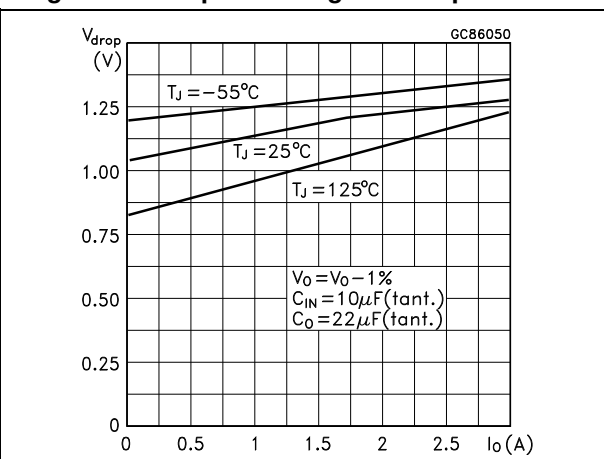


Figure 12. Adjust pin current vs. temperature

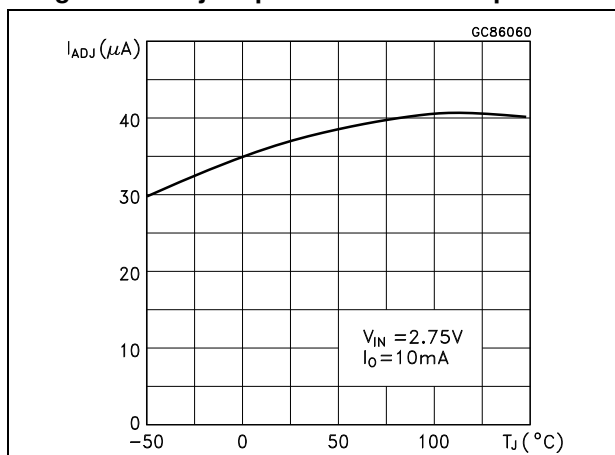


Figure 13. Quiescent current vs. temperature

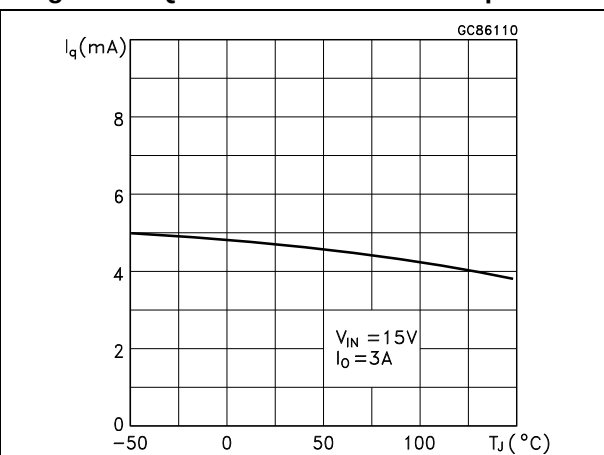


Figure 14. Line regulation vs. temperature
($V_{IN} = 15\text{ V}$)

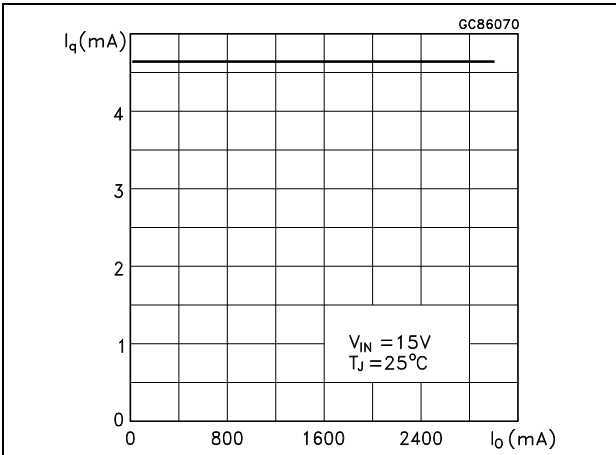


Figure 15. Supply voltage rejection vs. output current

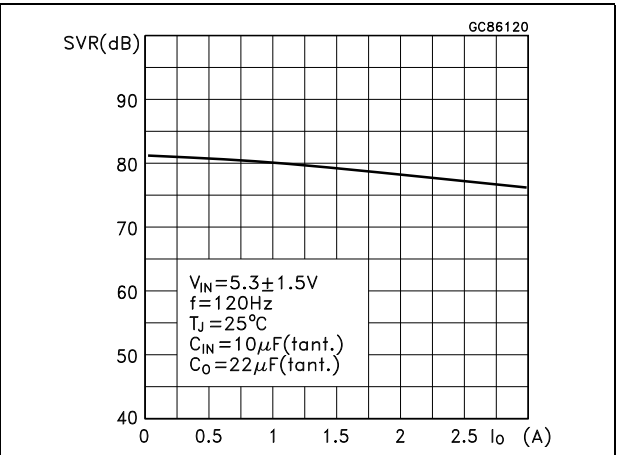


Figure 16. Supply voltage rejection vs. frequency

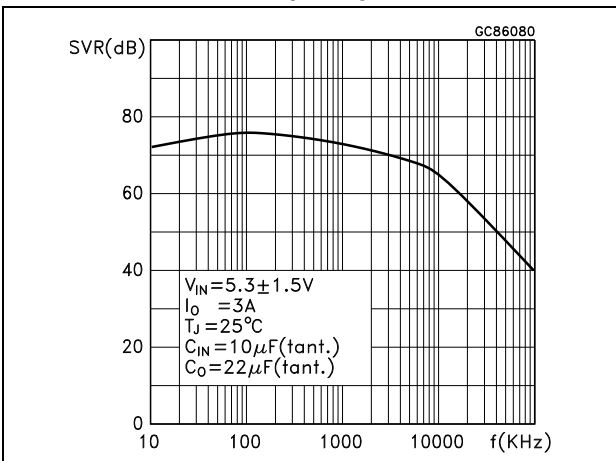


Figure 17. Supply voltage rejection vs. temperature

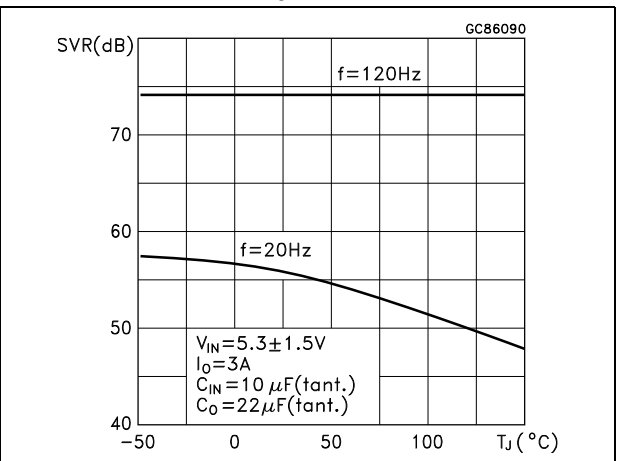


Figure 18. Minimum load current vs. temperature

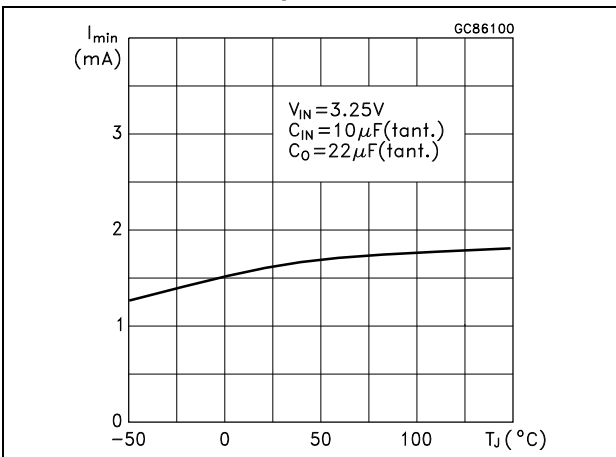


Figure 19. Stability, $V_O = 1.8\text{ V}$

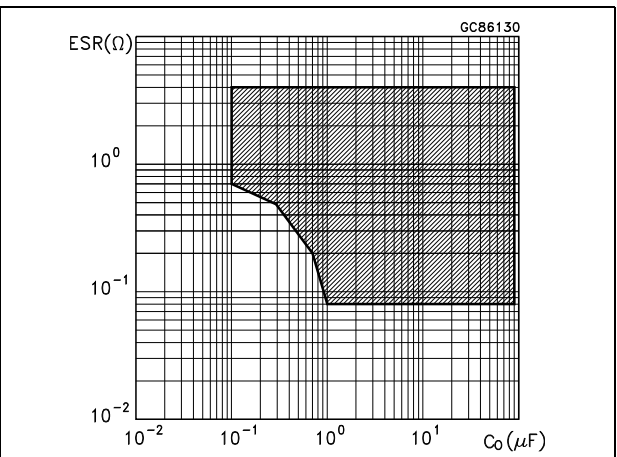


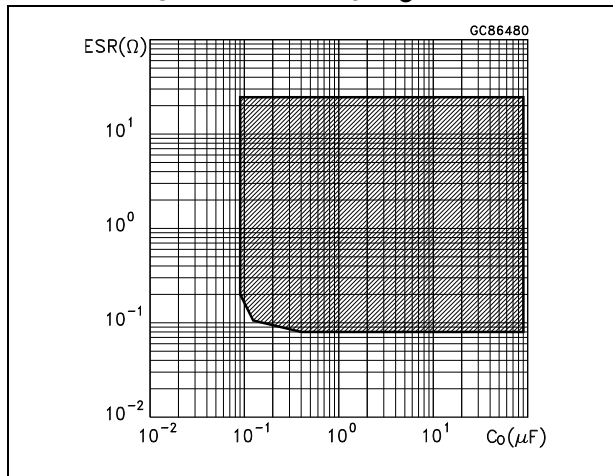
Figure 20. Stability, $V_O = 12\text{ V}$ 

Figure 21. Line transient

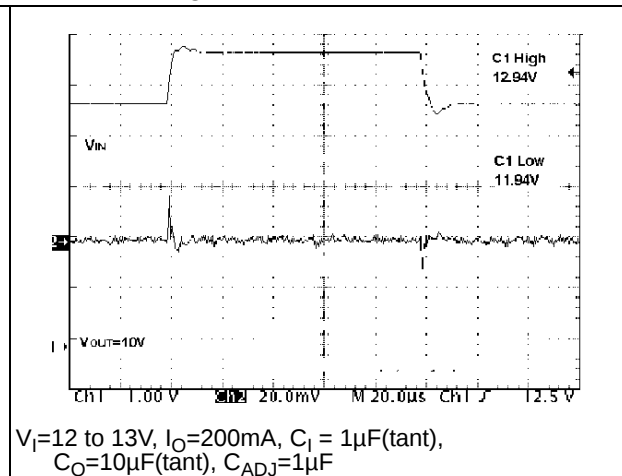
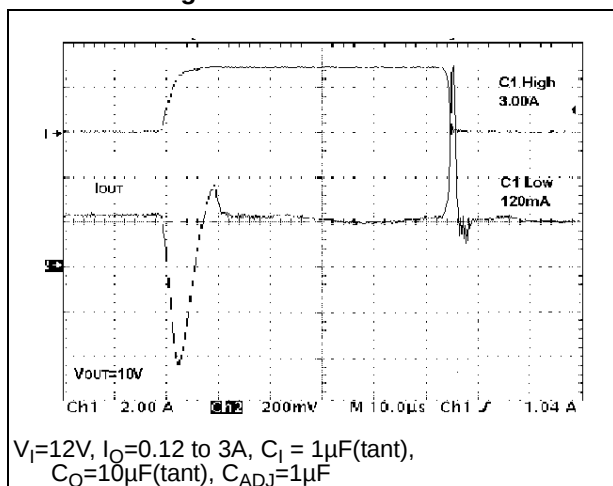
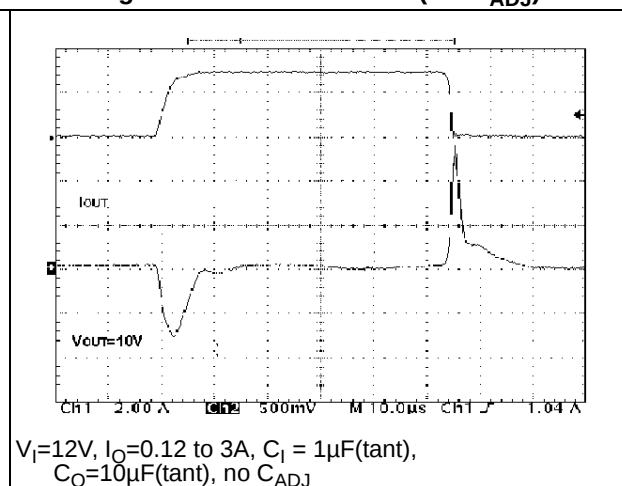


Figure 22. Load transient

Figure 23. Load transient (No C_{ADJ})

7 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

Table 8. TO-220 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	0.51		0.60
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
ØP	3.75		3.85
Q	2.65		2.95

Figure 24. TO-220 drawing

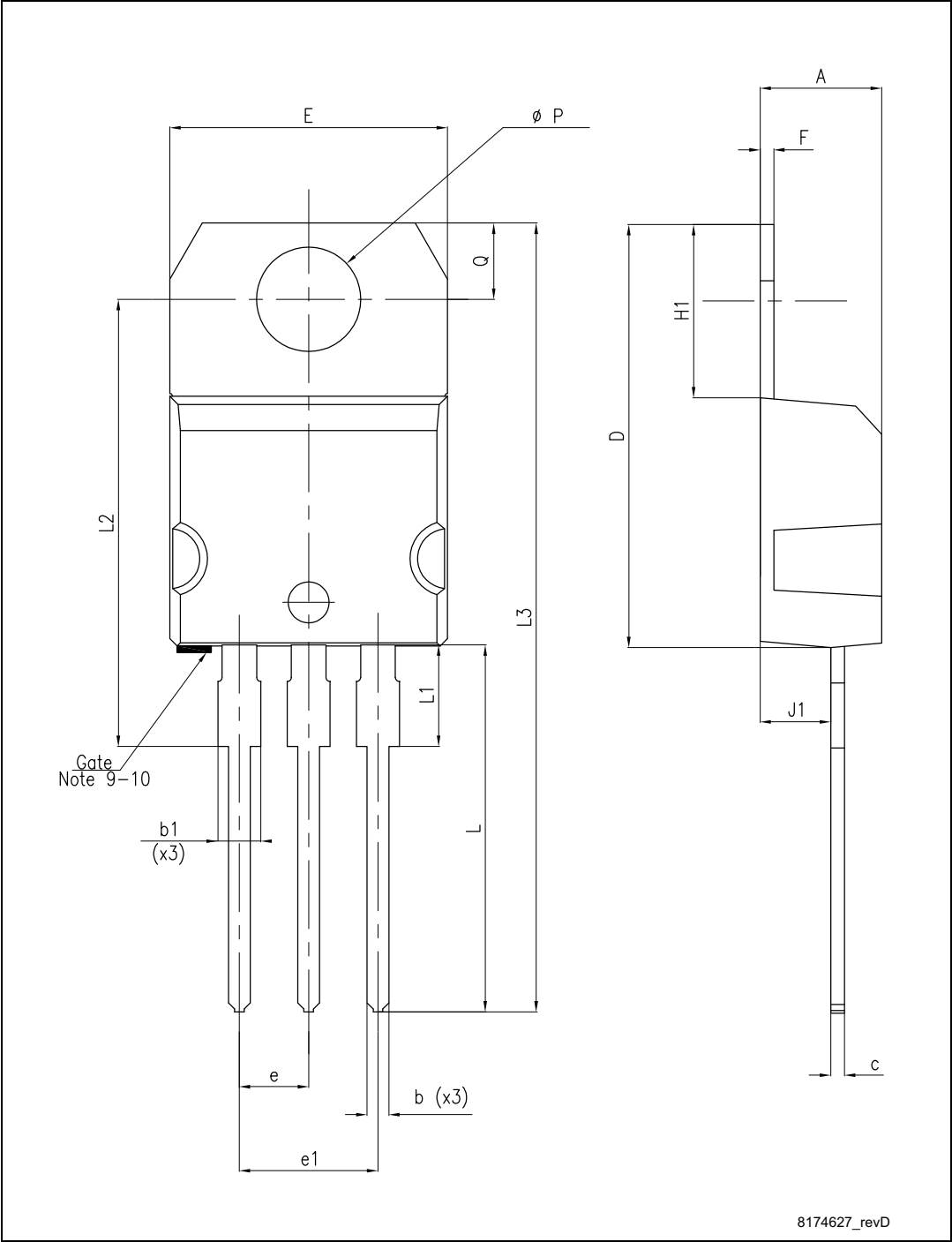
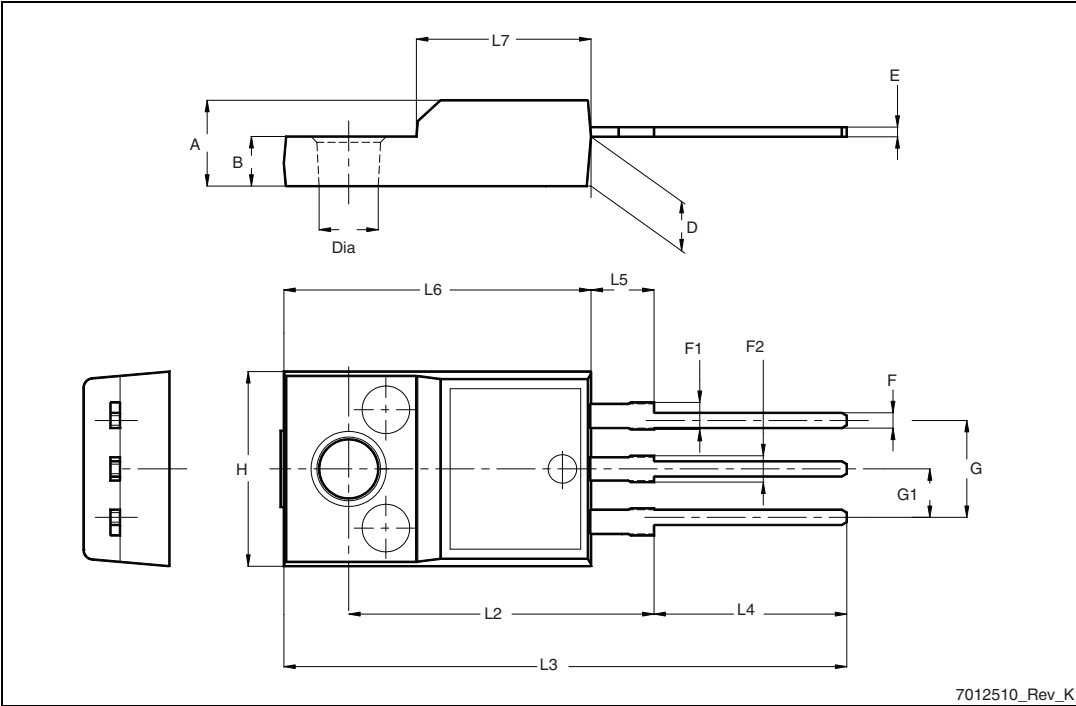


Table 9. TO-220FP mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 25. TO-220FP drawing



7012510_Rev_K

Table 10. D²PAK mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

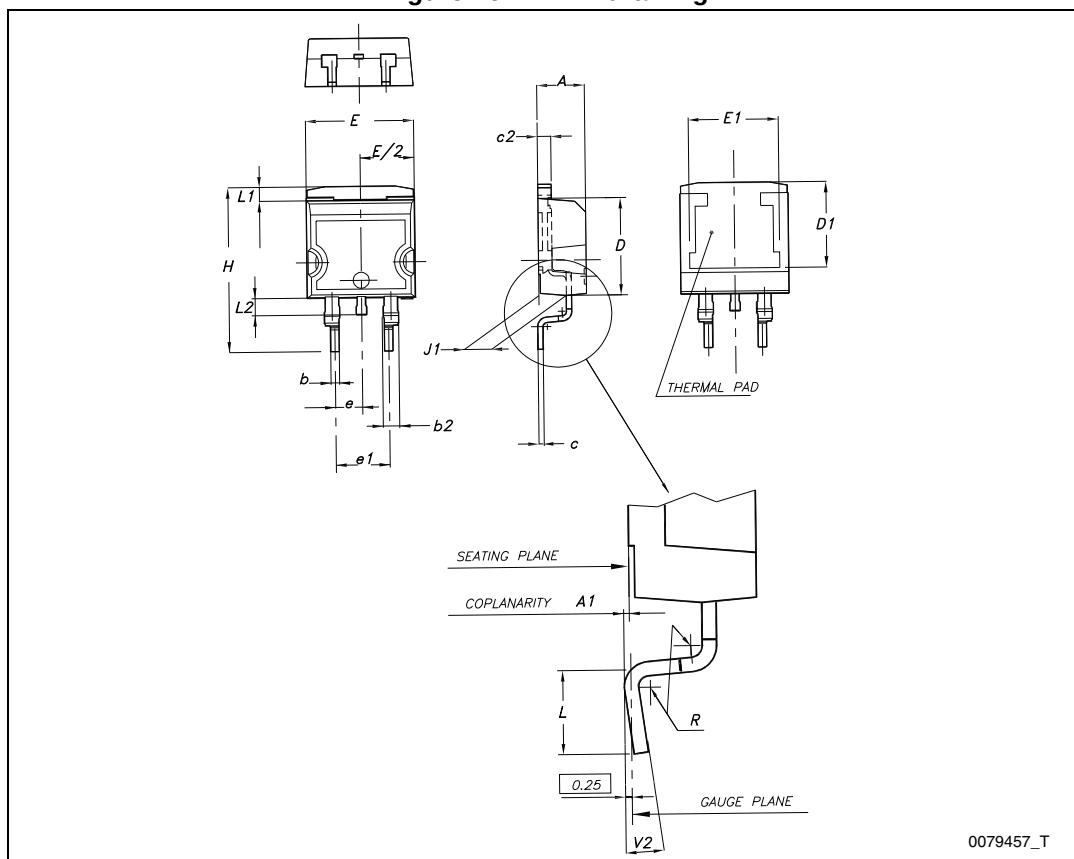
Figure 26. D²PAK drawing

Table 11. D²PAK/A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
R		0.4	
V2	0°		8°

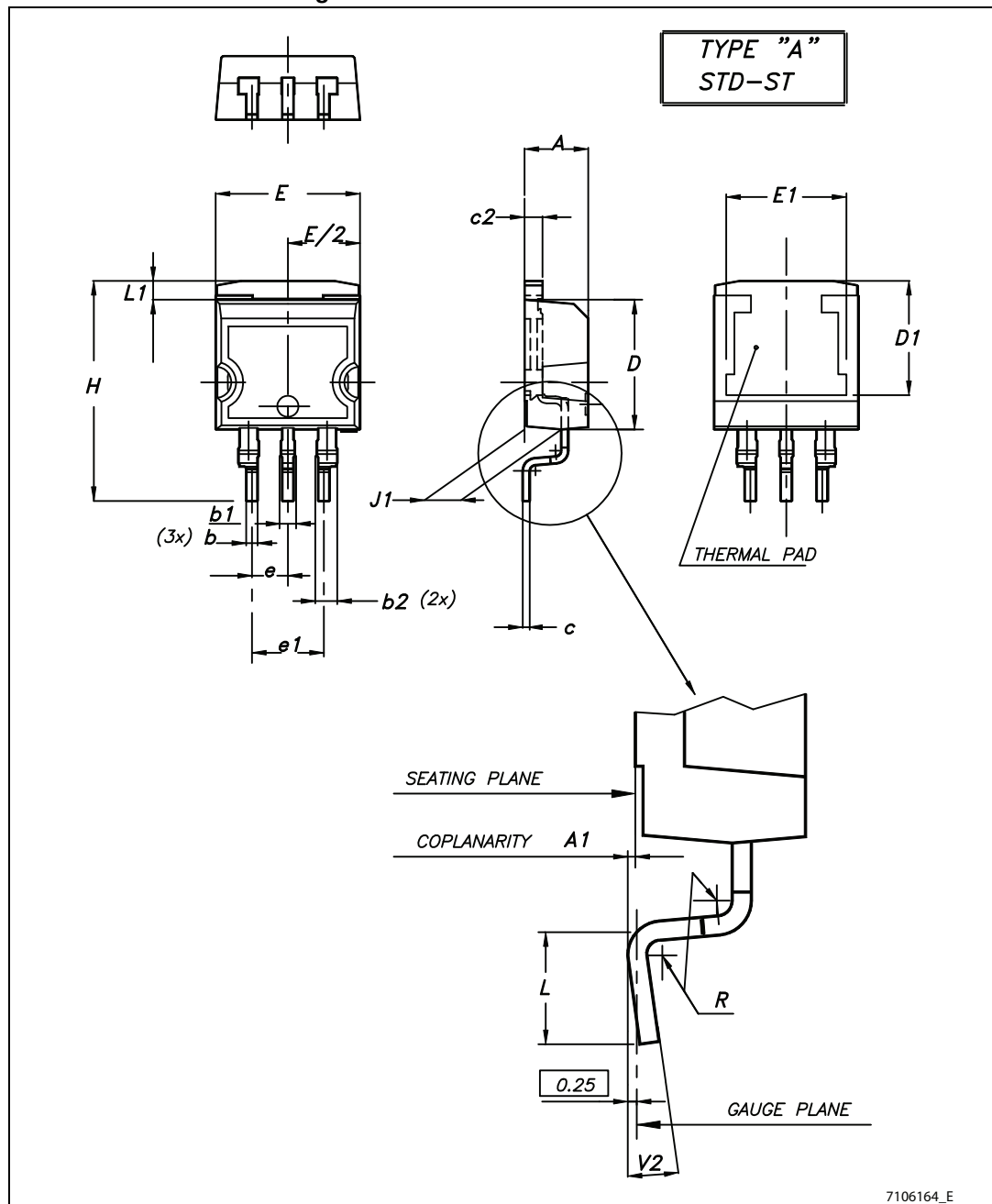
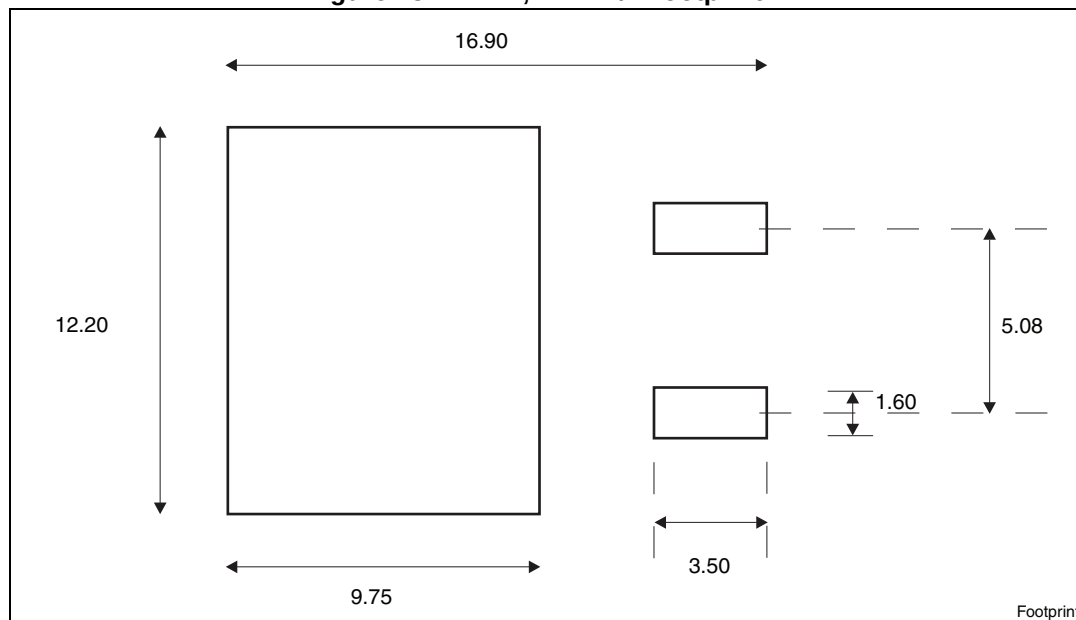
Figure 27. D²PAK/A mechanical data

Table 12. D²PAK, D²PAK/A tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base qty		1000
P2	1.9	2.1	Bulk qty		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

Figure 28. D²PAK, D²PAK/A footprint^(a)



a. All dimensions are in millimeters

Figure 29. Tape for D²PAK and D²PAK/A

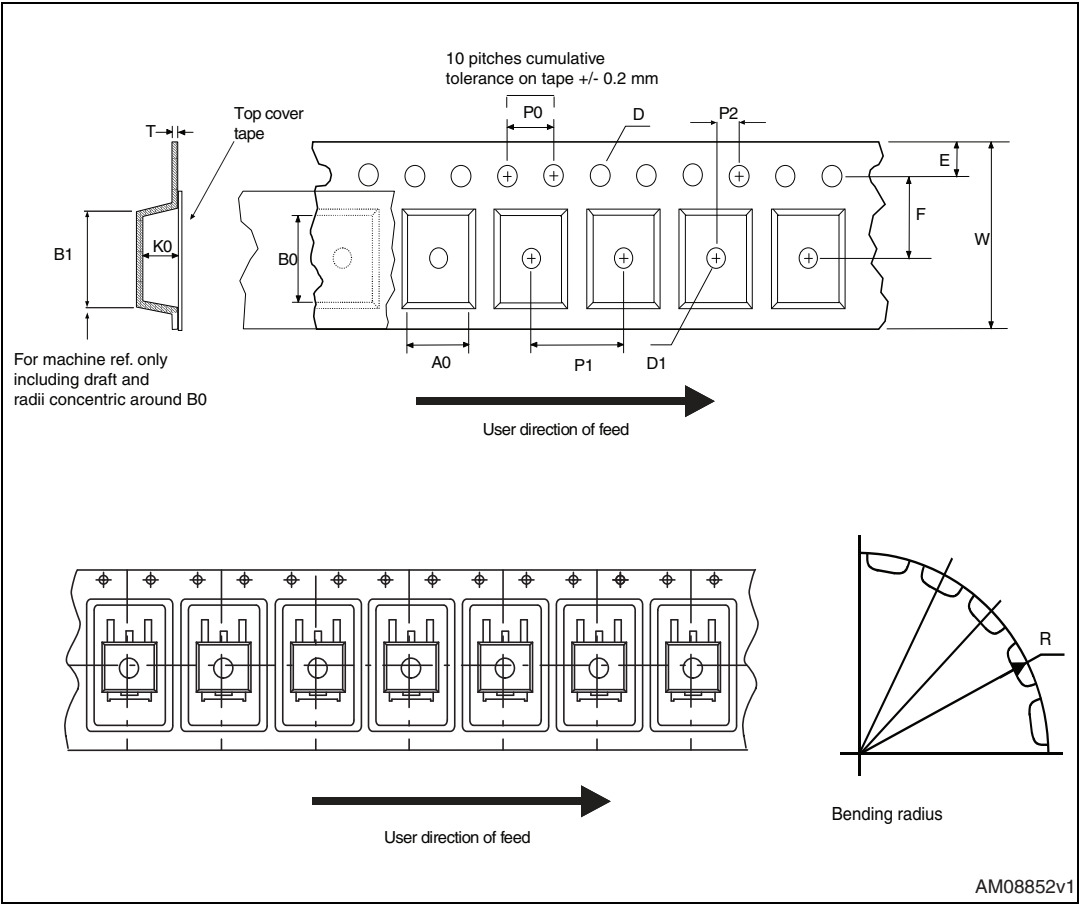
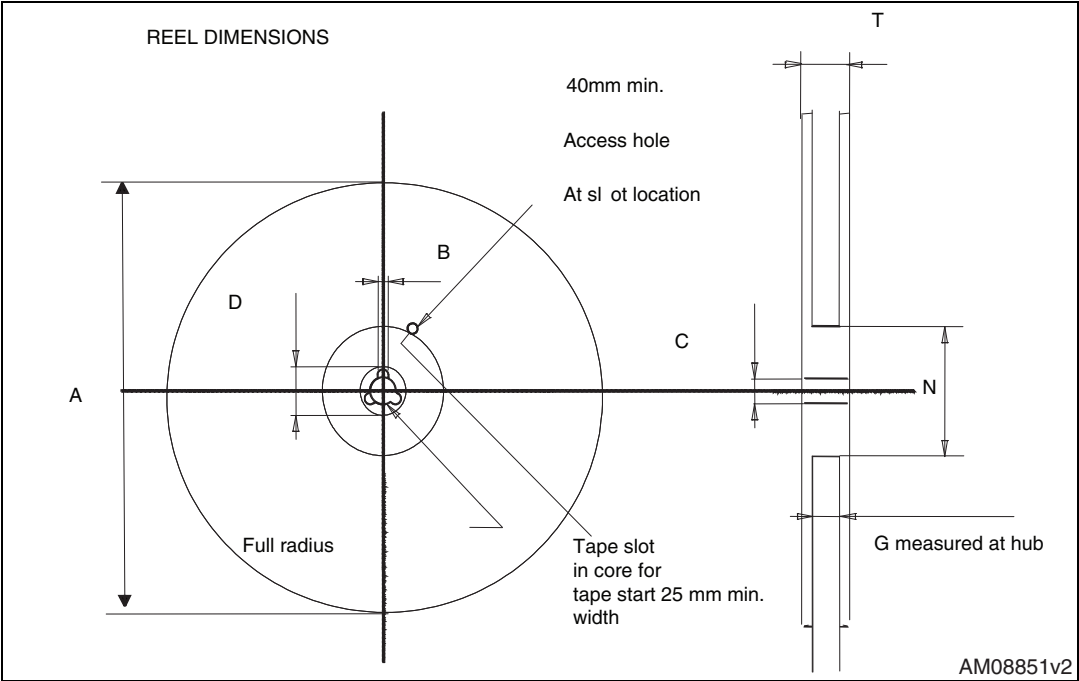


Figure 30. Reel for D²PAK and D²PAK/A



9 Order codes

Table 13. Order codes

Packages				Output voltage
TO-220	TO-220FP	D ² PAK	D ² PAK/A (T&R)	
			LD1085D2M18R	1.8 V
			LD1085D2M25R	2.5 V
		LD1085D2T33R	LD1085D2M33R	3.3 V
LD1085V50				5.0 V
LD1085V	LD1085P	LD1085D2T-R	LD1085D2M-R	ADJ

10 Revision history

Table 14. Document revision history

Date	Revision	Changes
07-Oct-2004	12	Mistake order codes - Table 1.
08-Feb-2005	13	Mistake U.M. load regulation - $V \Rightarrow$ mV.
01-Mar-2005	14	Version 1.2 V removed.
22-May-2006	15	Order codes has been updated and new template.
10-Nov-2006	16	Add package DPAK, typo on V_O test value in tables 3, 4 and 11.
04-Apr-2007	17	Order codes updated.
07-Jun-2007	18	Order codes updated.
05-Dec-2007	19	Modified: Table 13 .
29-Jan-2008	20	Added new order codes for Automotive grade products see Table 13 on page 25 .
18-Feb-2008	21	Modified: Table 13 on page 25 .
09-Apr-2008	22	Modified: Table 13 on page 25 .
14-Jul-2008	23	Modified: Table 13 on page 25 .
22-Aug-2008	24	Modified: Table 2 on page 5 .
28-Jul-2009	25	Modified: Table 13 on page 25 .
18-Feb-2013	26	– Modified Output voltage in Voltage reference parameter Table 7 on page 11 and Table 8 on page 12. – Minor text changes throughout the document.
08-Oct-2013	27	RPN LD1085xx changed to LD1085. Updated the Features and the Description in cover page. Cancelled Table1: Device summary, Table 9: Electrical characteristics of LD1085PY (Automotive Grade). Modified Figure 2: Pin connections (top view), Table 2: Thermal data, Table 13: Order codes, Section 7: Package mechanical data. Added Section 8: Packaging mechanical data. Minor text changes.

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

ST PRODUCTS ARE NOT DESIGNED OR AUTHORIZED FOR USE IN: (A) SAFETY CRITICAL APPLICATIONS SUCH AS LIFE SUPPORTING, ACTIVE IMPLANTED DEVICES OR SYSTEMS WITH PRODUCT FUNCTIONAL SAFETY REQUIREMENTS; (B) AERONAUTIC APPLICATIONS; (C) AUTOMOTIVE APPLICATIONS OR ENVIRONMENTS, AND/OR (D) AEROSPACE APPLICATIONS OR ENVIRONMENTS. WHERE ST PRODUCTS ARE NOT DESIGNED FOR SUCH USE, THE PURCHASER SHALL USE PRODUCTS AT PURCHASER'S SOLE RISK, EVEN IF ST HAS BEEN INFORMED IN WRITING OF SUCH USAGE, UNLESS A PRODUCT IS EXPRESSLY DESIGNATED BY ST AS BEING INTENDED FOR "AUTOMOTIVE, AUTOMOTIVE SAFETY OR MEDICAL" INDUSTRY DOMAINS ACCORDING TO ST PRODUCT DESIGN SPECIFICATIONS. PRODUCTS FORMALLY ESCC, QML OR JAN QUALIFIED ARE DEEMED SUITABLE FOR USE IN AEROSPACE BY THE CORRESPONDING GOVERNMENTAL AGENCY.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2013 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com